Restoration of Cold Water Refugia in the Upper Columbia River Estuary

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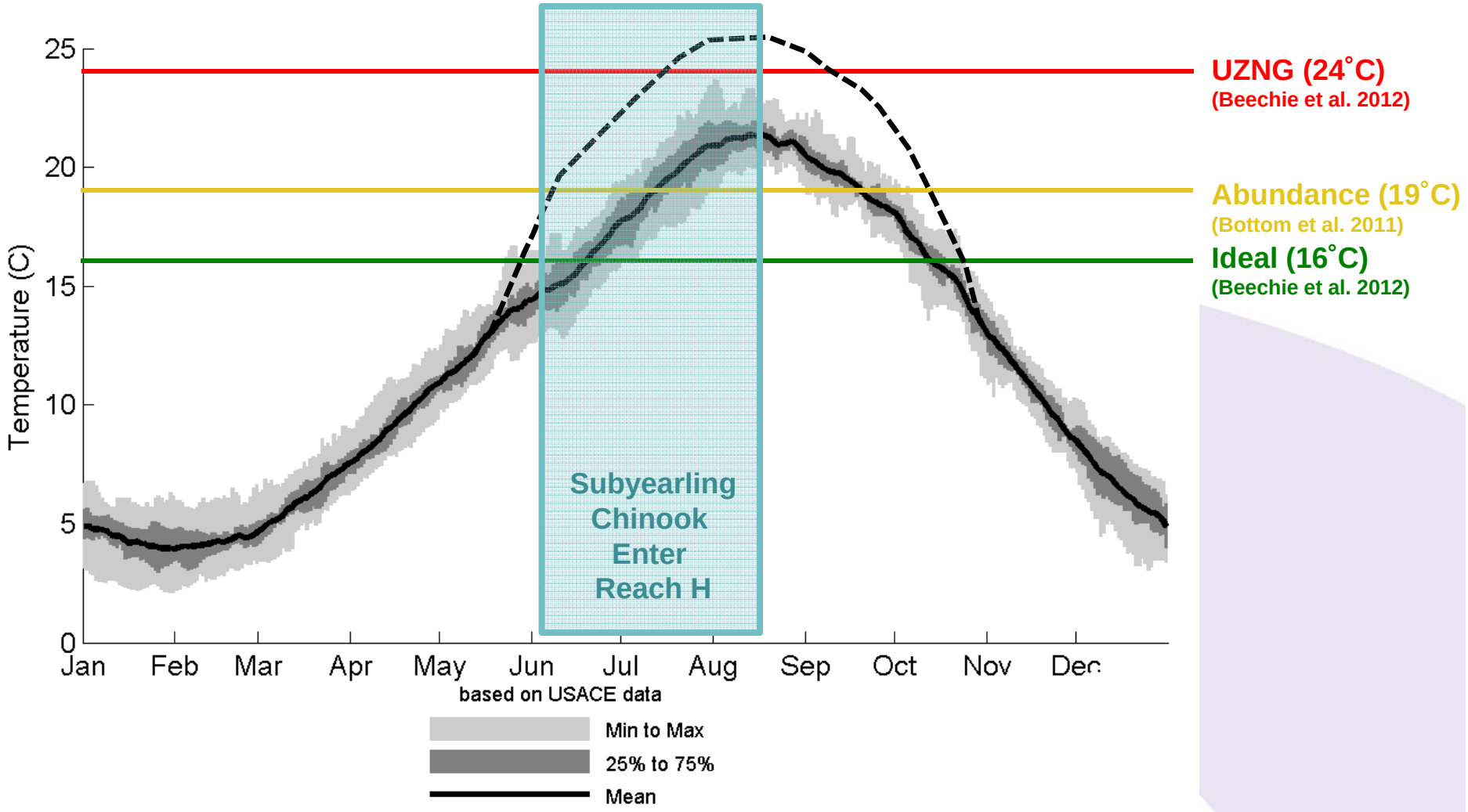
Lower Columbia Estuary Partnership

Mainstem thermal regime during outmigration



Potential benefits and impacts of thermal refugia

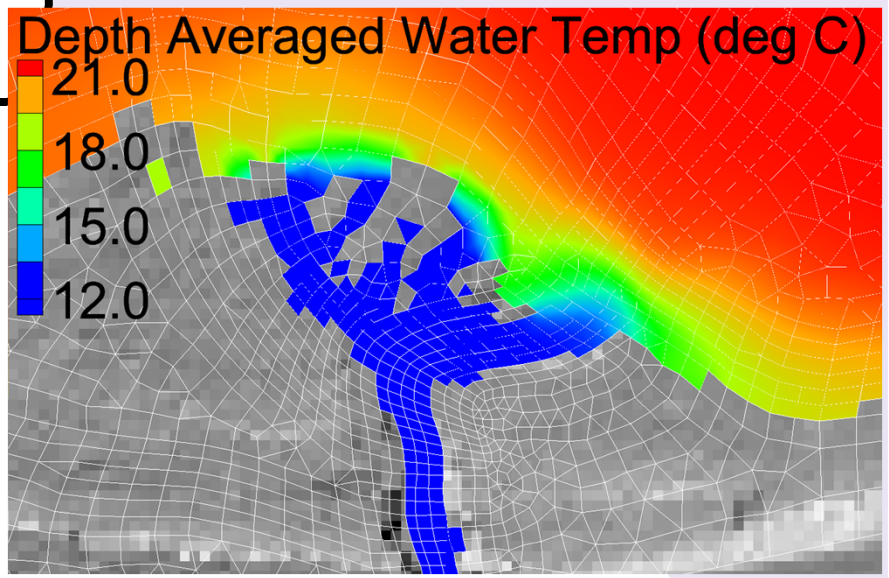
- Numerous potential benefits and impacts associated with thermal refugia, e.g., predation.
- *Diversity & Resilience*:
  - *Five life history strategies* documented in single populations of Chinook and coho (Reimers 1973; Craig 2010).
  - A diversity of available habitats, e.g., varied thermal conditions, supports a variety of species and life histories, which is important for salmon populations that will be ***resilient*** in the face of ecological disturbance.

Characteristics of thermal refugia

Organized by attributes presented in *Ecological Assessment Criteria for Restoring Anadromous Salmonid Habitat in Pacific Northwest Estuaries* (Simenstad and Cordell, 2000)

- **Opportunity/Access**:
  - Adjacent to mainstem
  - Detection: - Plume must extend into the migratory corridor
    - Temp. differential (2-7˚C cued adults above Bonneville) (Keefer et al. 2011)
- **Capacity**:
  - Temperature: - physiological: <19˚C (Bottom et al. 2011)
    - protection from predators: <19˚C (Moyle 2002)
  - Depth: minimum of ~0.5m for juveniles (Bottom et al. 2005)
  - Horizontal extent: uncertain

Design Criteria: - <17°C (19°C minus 2°C diff.)
- >0.5m depth
- max. spatial extent practical



Example Projects

What actions reduce the effects of climate change & promote resiliency?

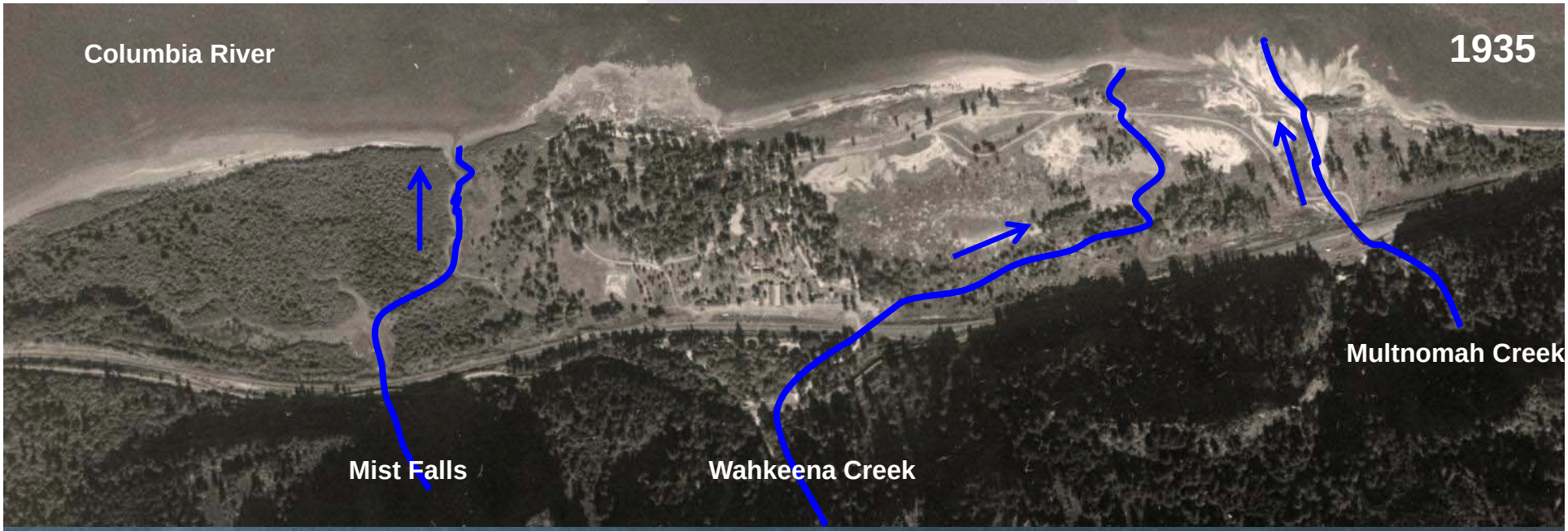
1. Decrease stream temperatures
2. Increase base flow
3. Increase resiliency (i.e., allow for expression of full range of life histories)

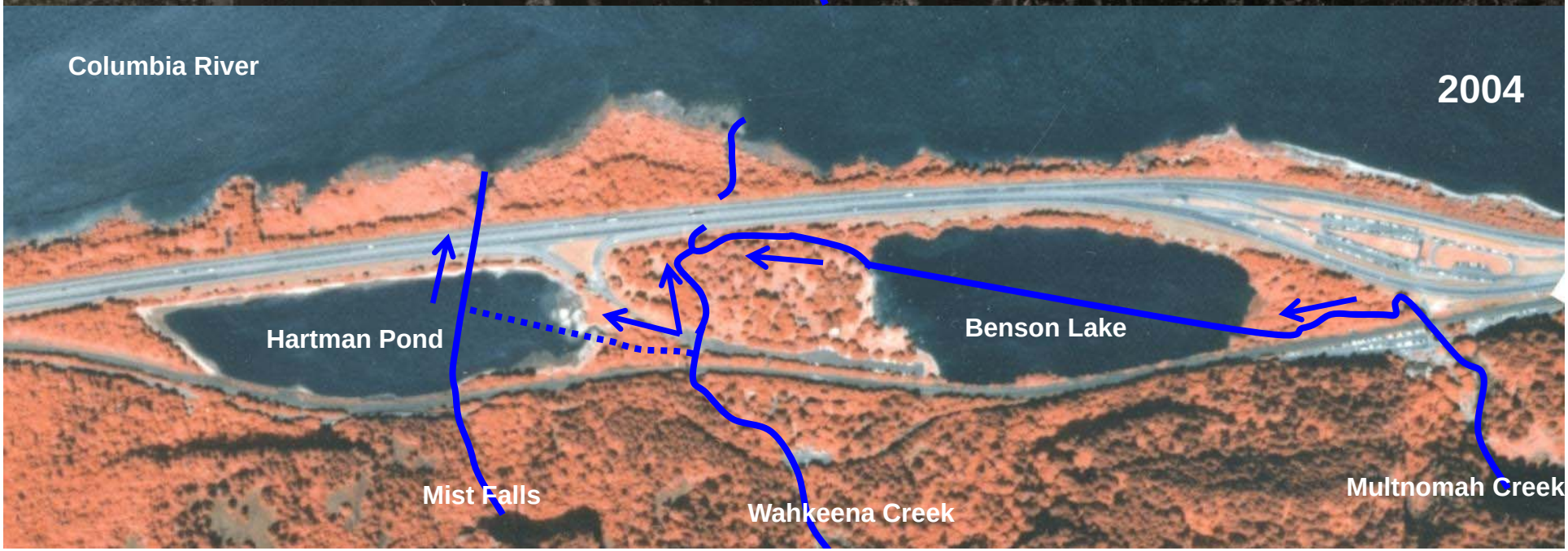
Source: Beechie et al. 2012

Oneonta Cr. Diversion - 2012

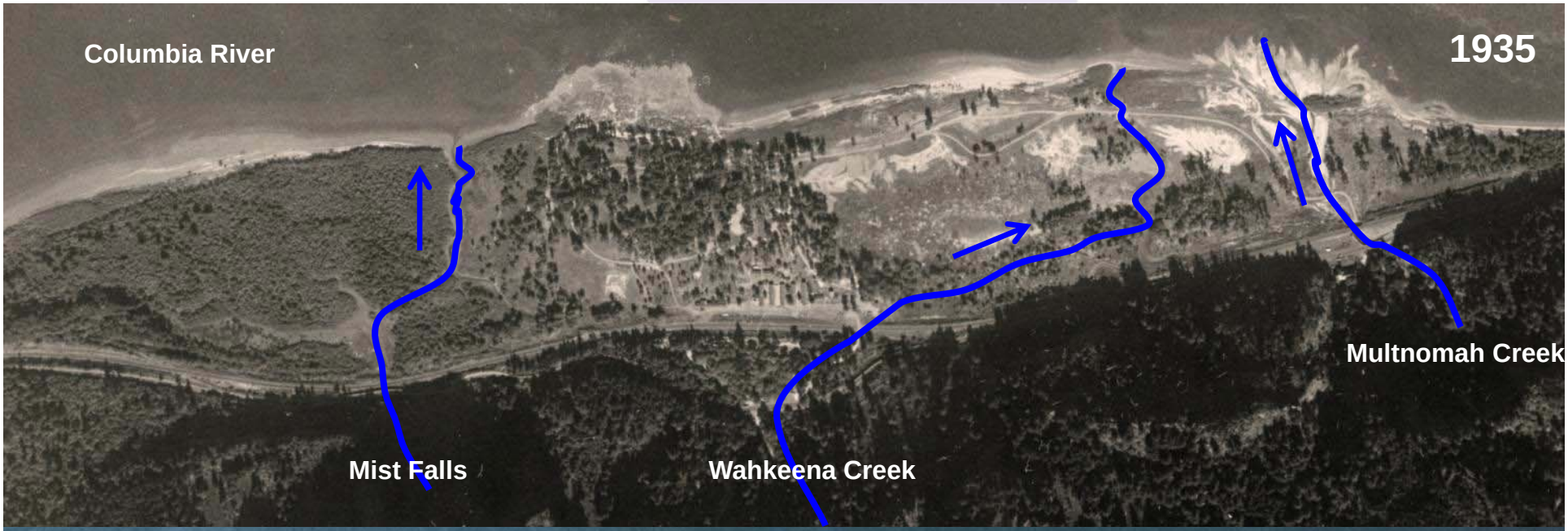
Oneonta Cr. - 2013

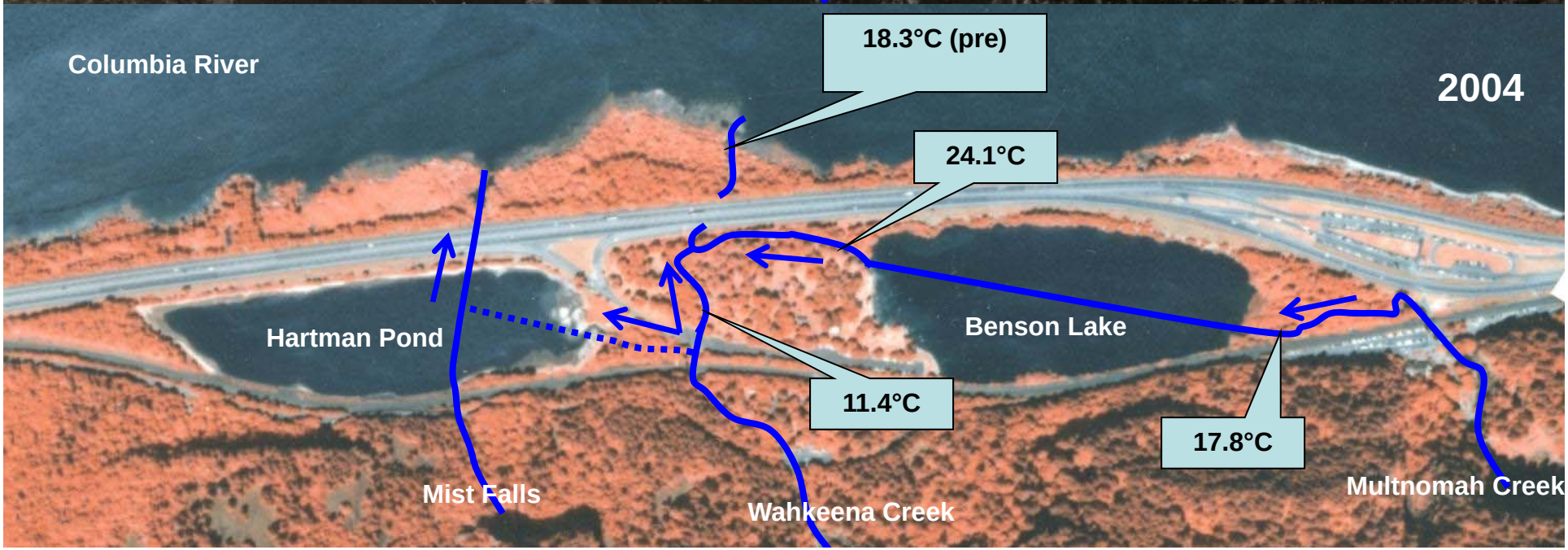
Example Projects





Example Projects – Example 1: restore instream flow (reduce withdrawals, water rights acq.)





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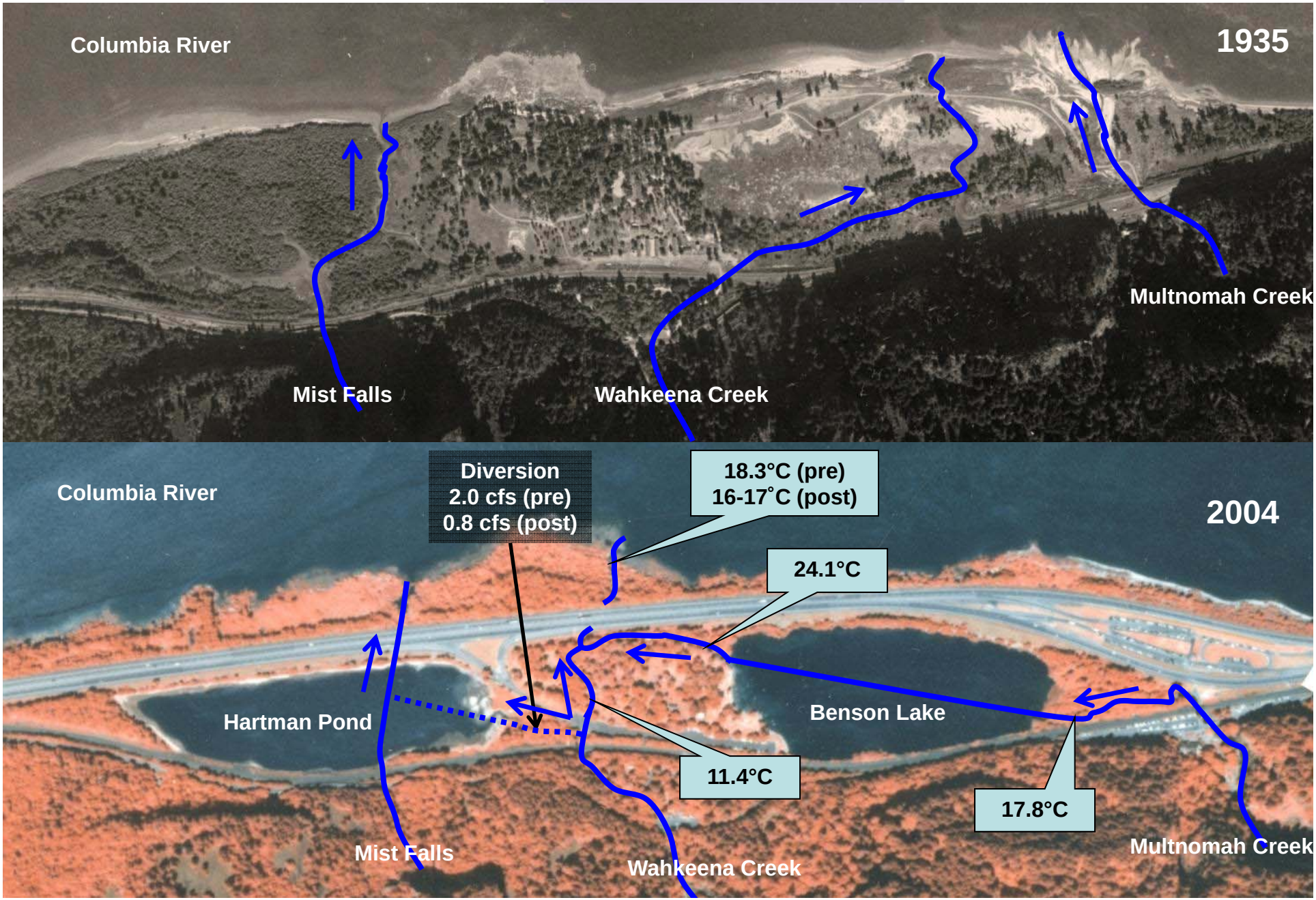
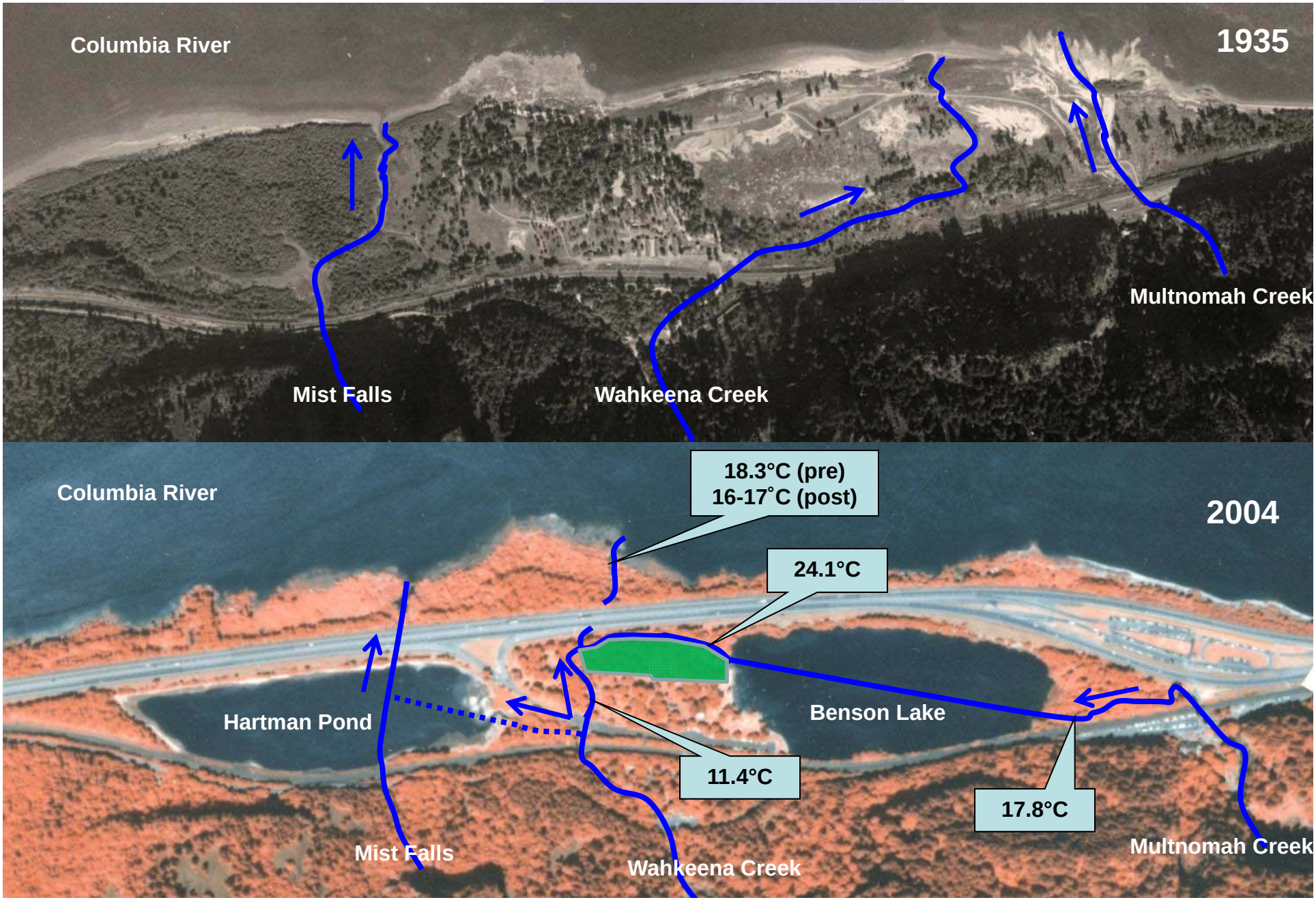
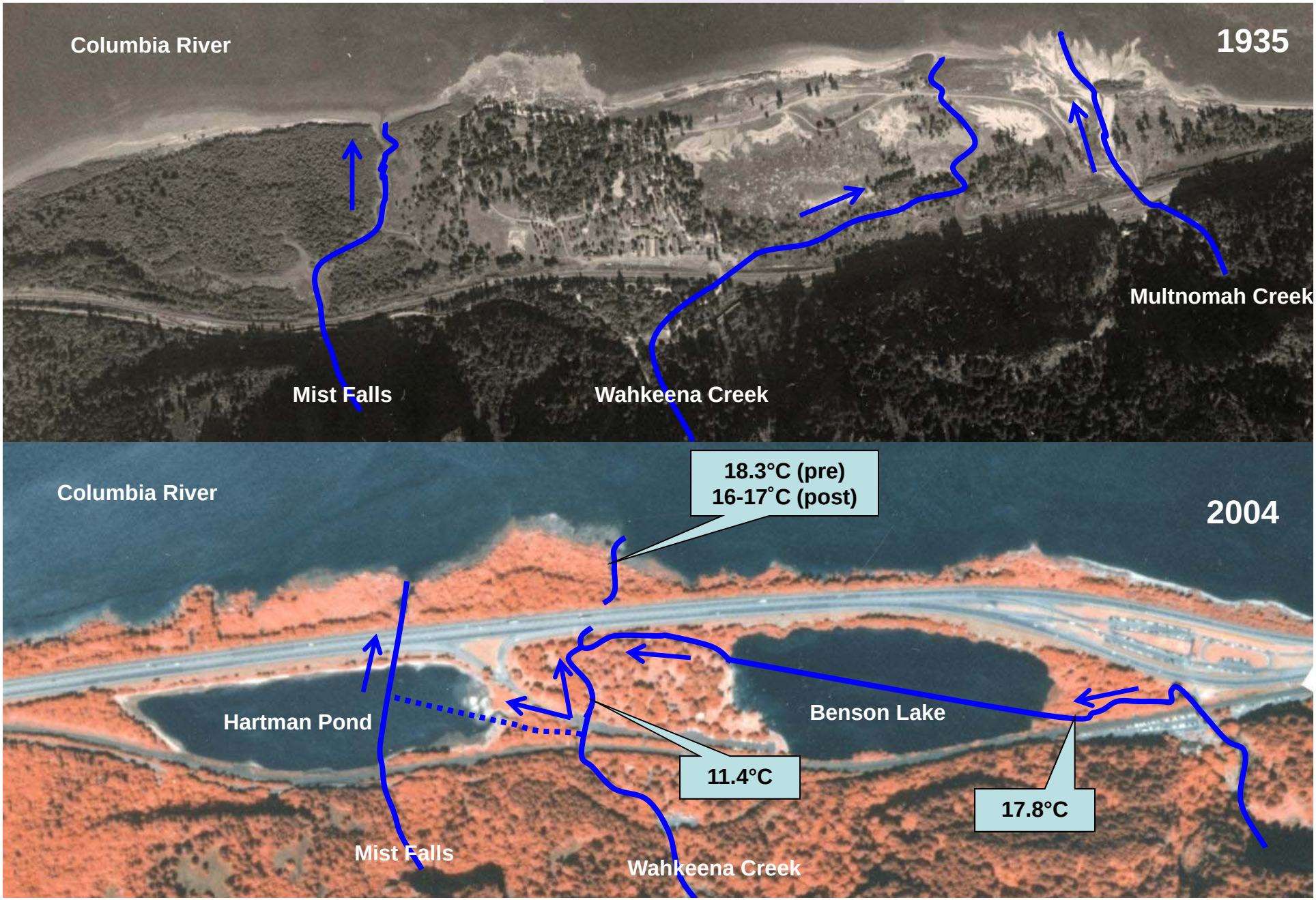


Example Projects – Example 2: riparian restoration



Example Projects – Example 3: longitudinal connectivity (barrier removal)



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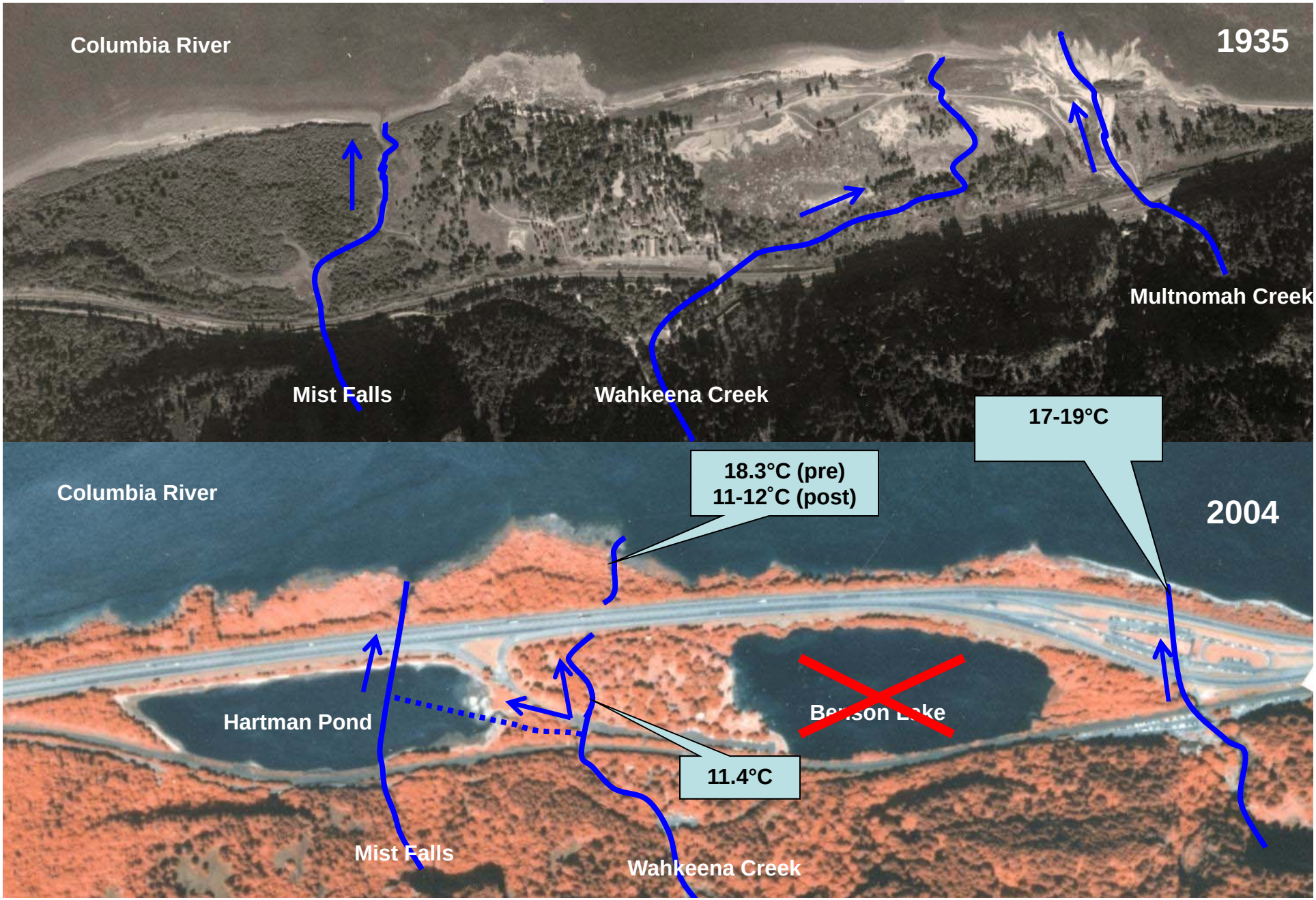
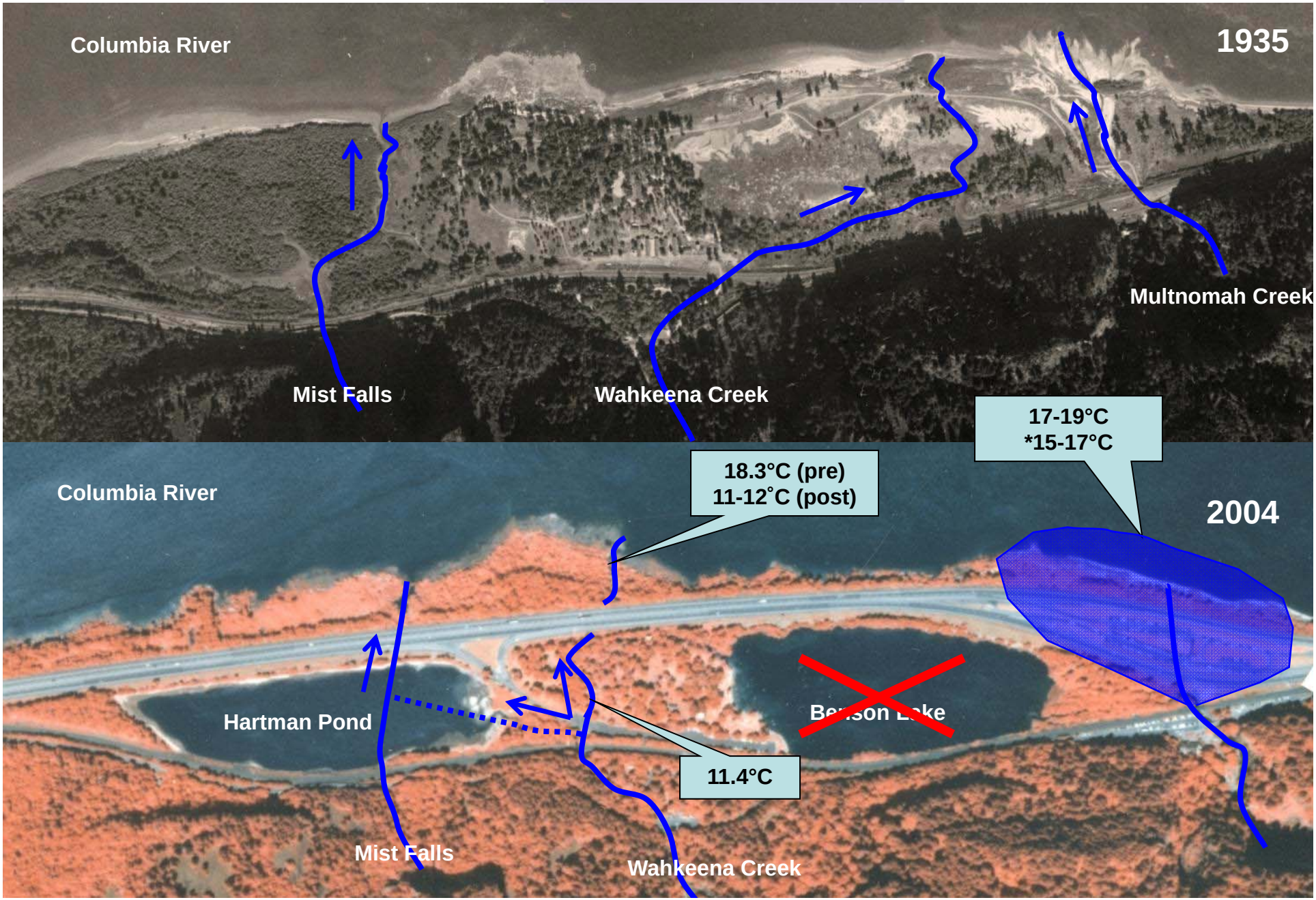
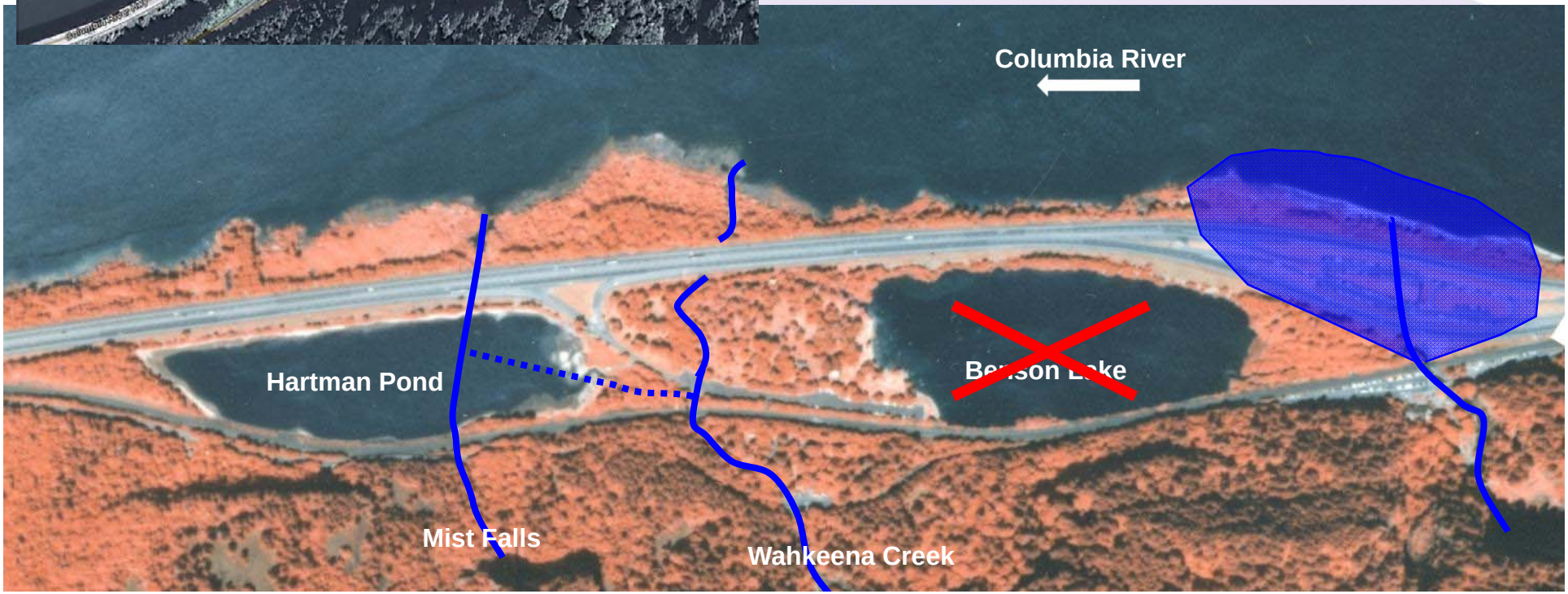


Example Projects – Example 4: lateral connectivity (reconnecting floodplain features)



Example Projects – Example 5: instream rehabilitation (mainstem structure to expand plume)



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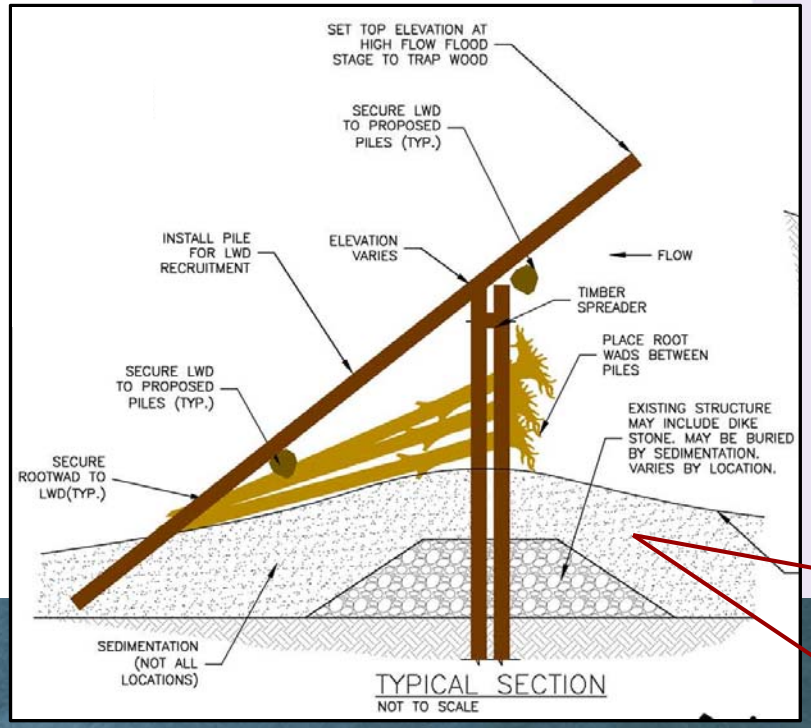
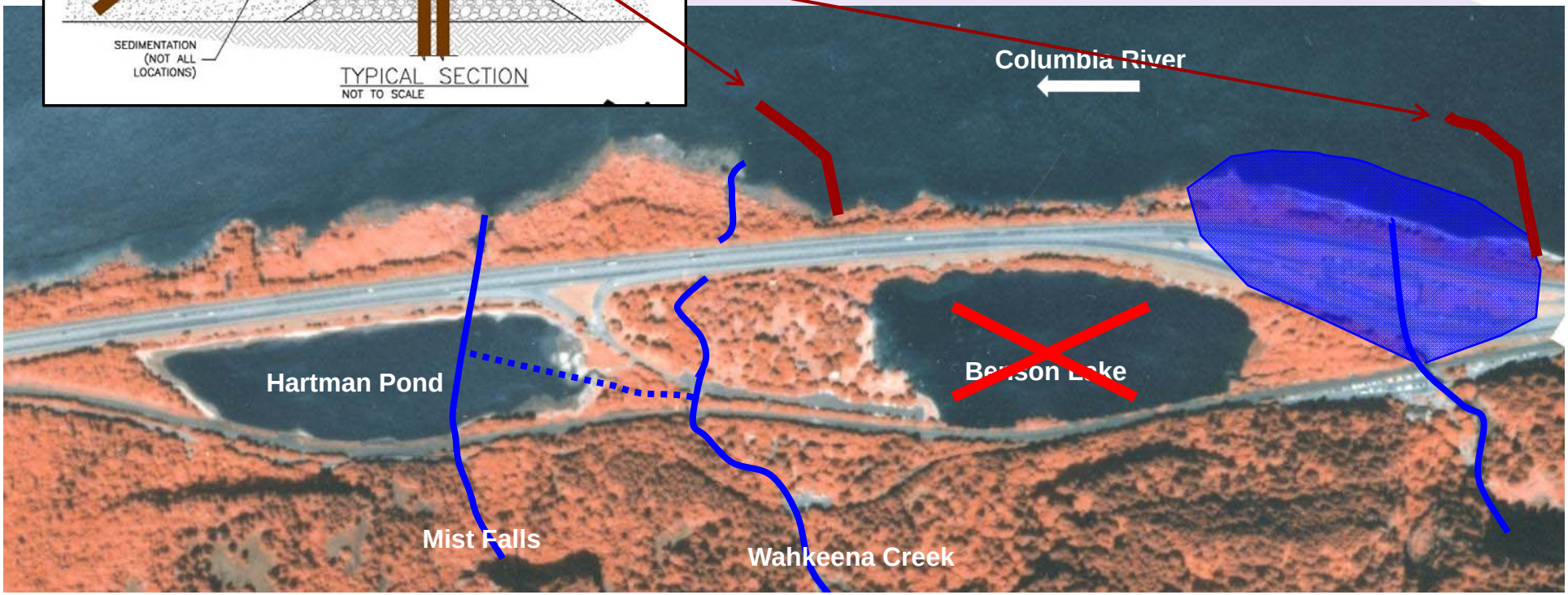
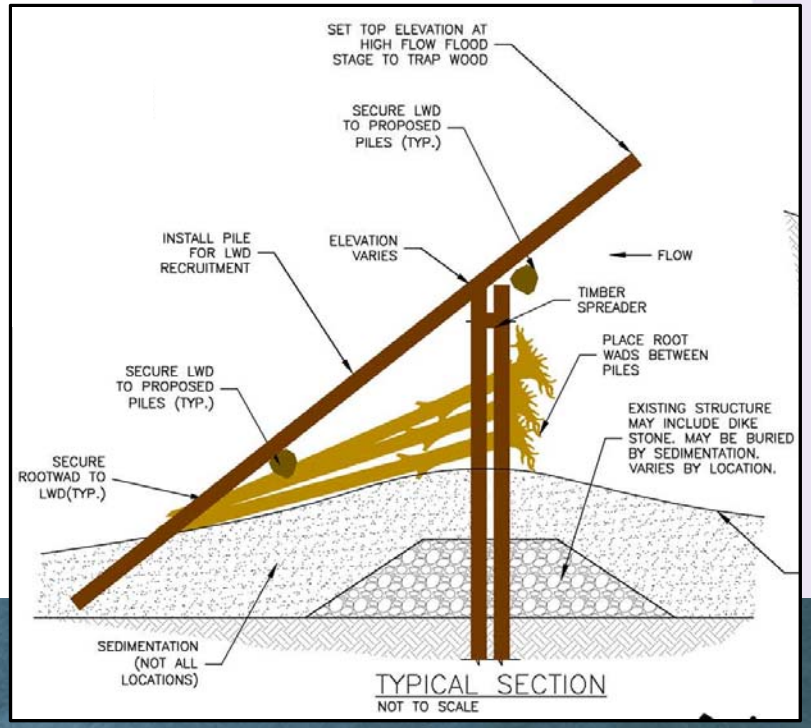




Example Projects – Example 5: instream rehab. (structural diversity to increase capacity)



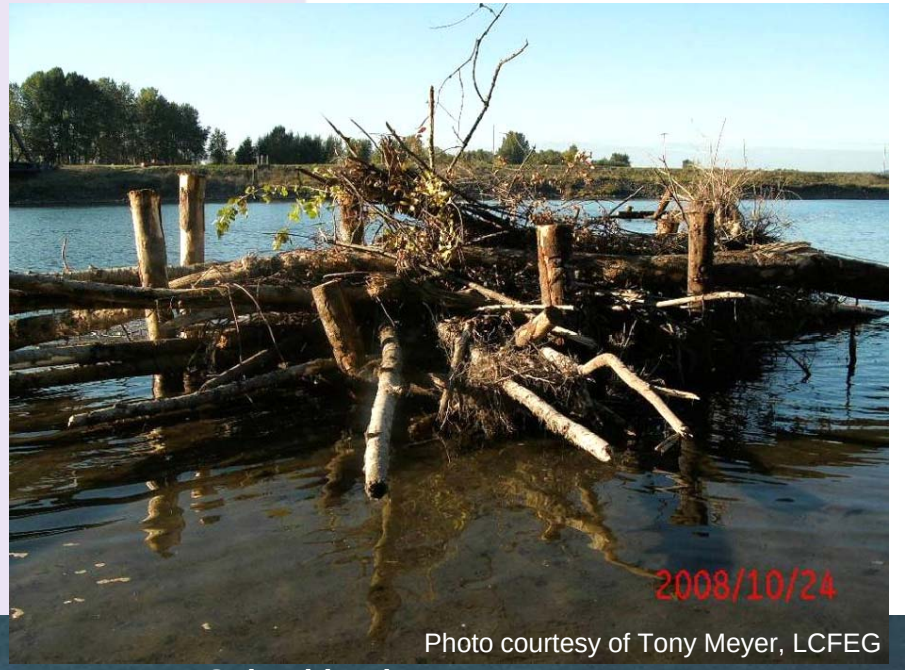
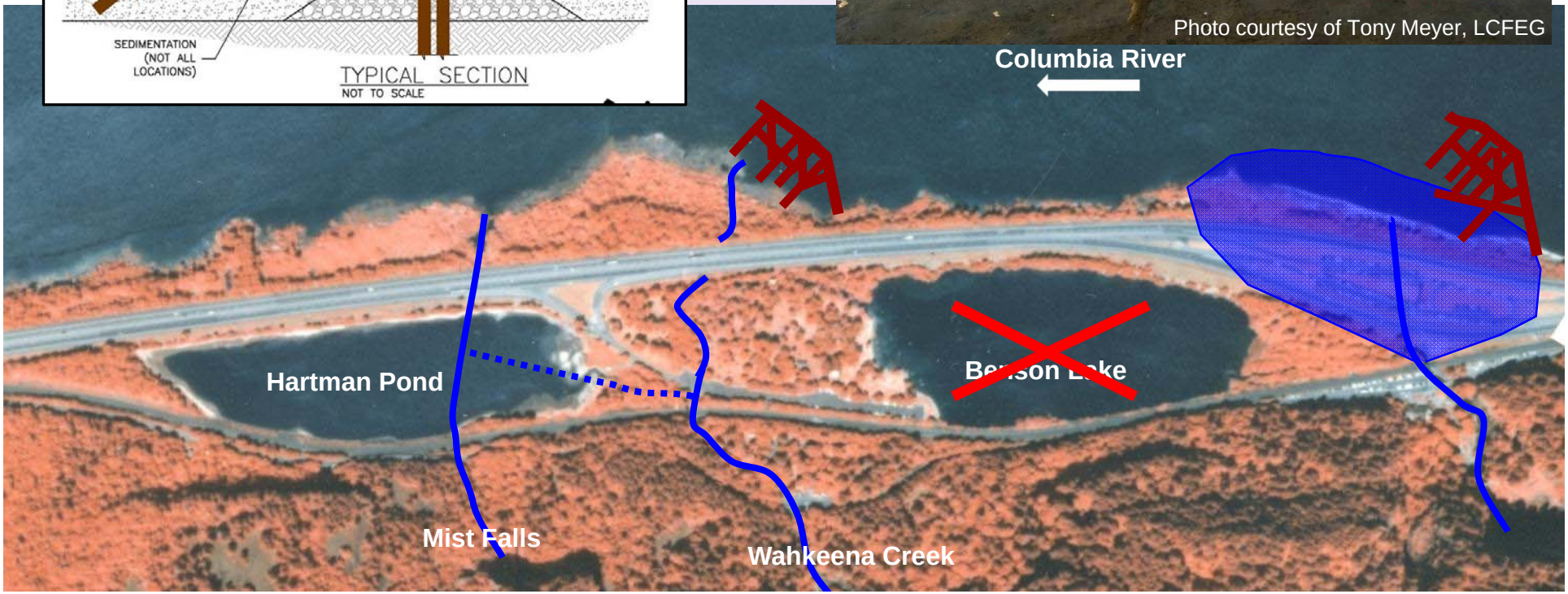
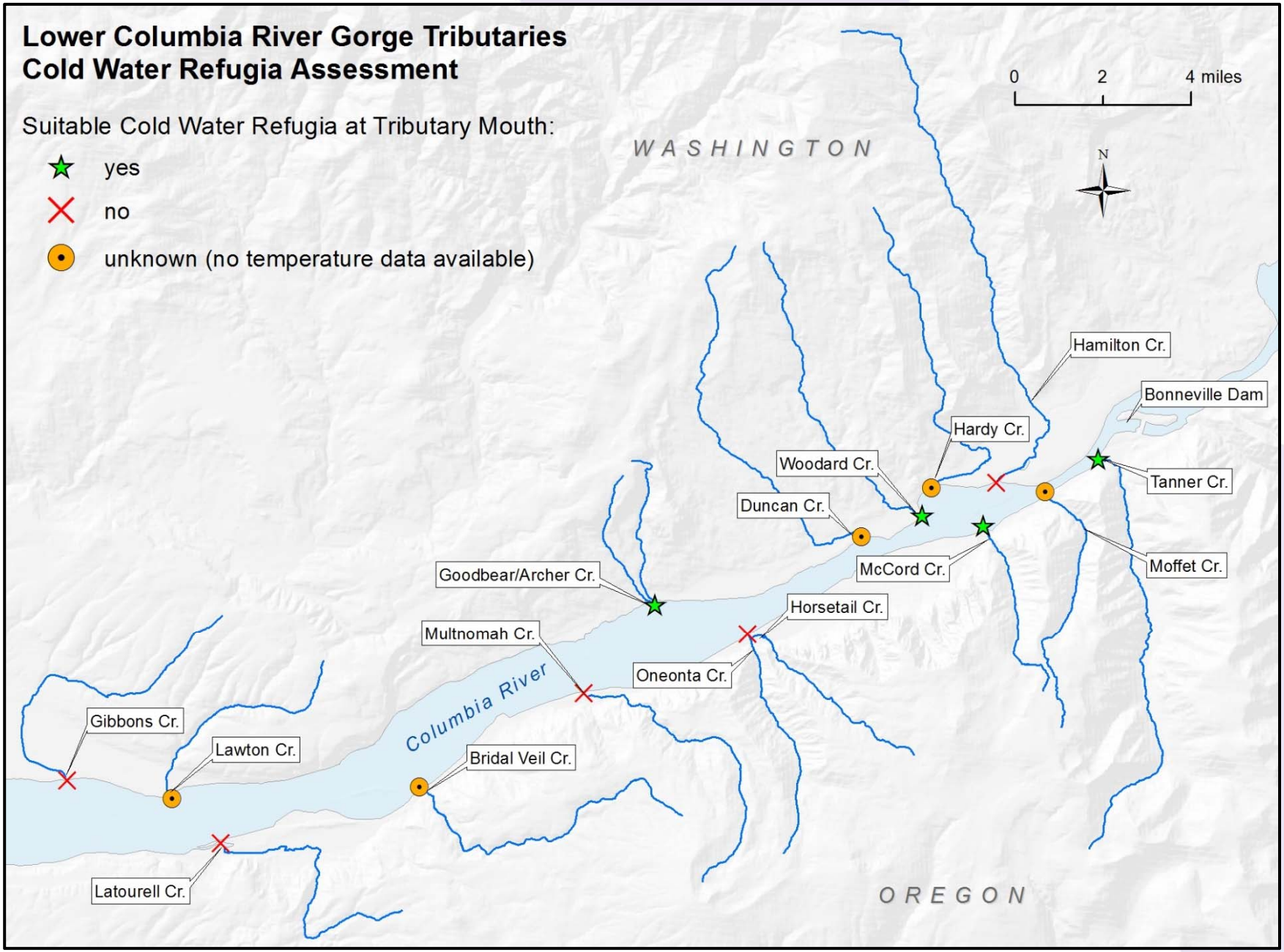


Photo courtesy of Tony Meyer, LCFEG

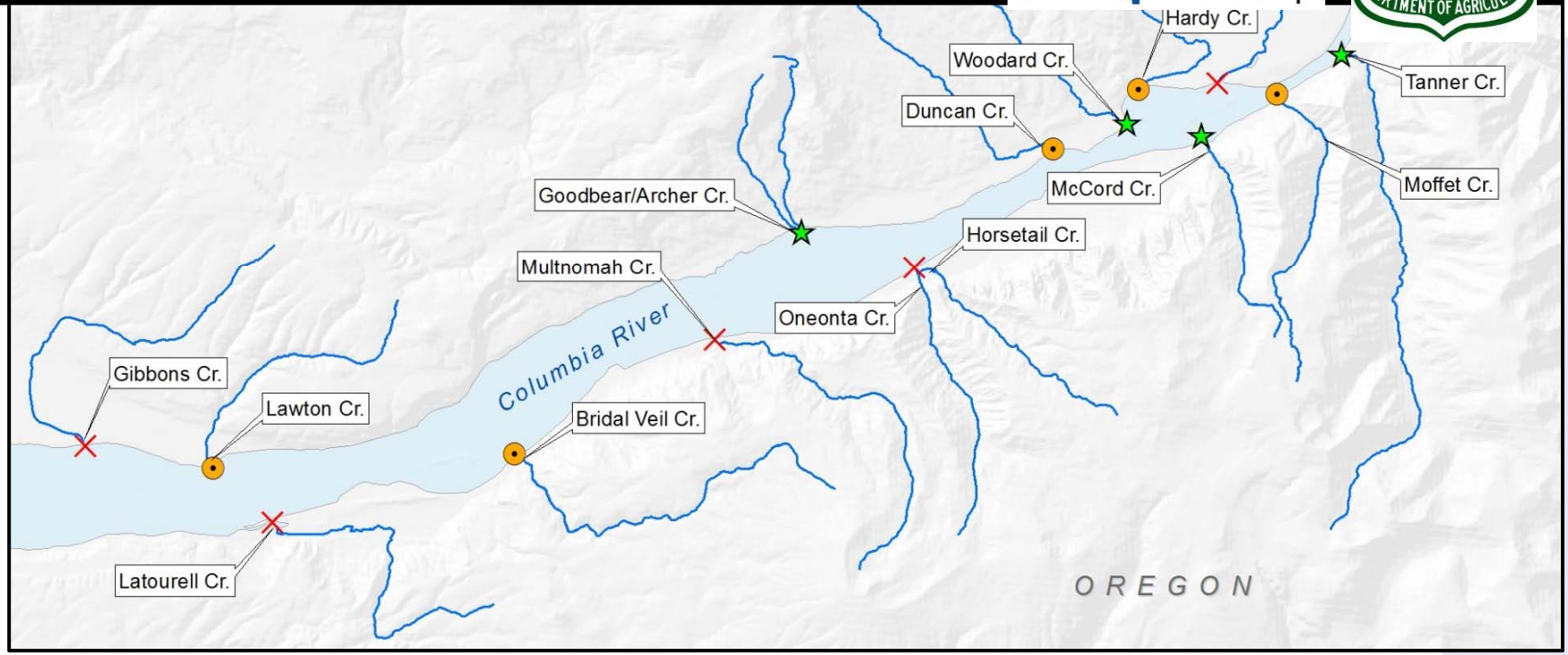


Current and Potential Thermal Refugia in Reach H



Current and Potential Thermal Refugia in Reach H

- EP and USFS completed a Watershed Restoration Action Plan for Reach H
- Results included……
  - Reduce/eliminate **7 stream diversions, 5 of which** likely effect temperature
  - Remove/retrofit **3 passage barriers** that would provide longitudinal connectivity to thermal refugia
  - Restore **lateral connectivity at 3 sites**
  - Riparian plantings at a variety of locations



Thanks….

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Matt Keefer, U. of Idaho
Tim Beechie, NMFS

Questions?

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